ADDITIONAL NOTES ON THE GENUS AVICENNIA. VIII

Harold N. Moldenke

AVICENNIA L.

Additional synonymy: Avicenina L. ex Alston in Trimen, Handb. Fl. Ceylon 6: Suppl. 233, sphalm. 1931. Trepanocarpus Mart., in herb.

Additional & emended bibliography: Forst. f., Fl. Escul. Ins. Ocean. Austr. 72. 1786; Forst. f., Fl. Ins. Austr. Prod. 45. 1786; W. Griff., Notul. Pl. Asiat. 4: 185—195. 1854; Beddome, Fl. Sylv. Anal. Gen. 174, pl. 22, fig. 2. 1872; Bocq.-Lim., Palét. Mangl. 31 & 114—121. 1911; E. D. Merr., Fl. Manila, imp. 1, 397. 1912; Annal. Mus. Colon. Marseille, ser. 4, 4: 2, pl. 64. 1926; Mém. Acad. Malgache 5: pl. 20, fig. 56. 1927; Bull. Imp. Inst. Lond. 37: 336. 1939; Pilgrim, Indian Forest Leafl. 72: 5. 1944; Sonohara, Tawada, & Amano [ed. E. H. Walker], Fl. Okin. 131. 1952; Santapau, Bull. Bot. Surv. India 8: 37, 40, & 291. 1966; E. D. Merr., Fl. Manila , imp. 2, 397. 1968; Bolkh., Grif, Matvej., & Zakhar.,Chrom. Numb. Flow. Pl., imp. 1, 714. 1969; Tan & Keng, Journ. Singapore Nat. Acad. Sci. 1: 8—29. 1969; G. W. Thomas, Tex. Pl. Ecolog. Summ. 77. 1969; V. J. Chapm., Salt Marshes & Salt Des., ed. 2, xvi, 212, 229, 233, 234, & 374, pl. 34b. 1973; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 2, 714. 1974; R. W. Long, Fla. Sci. 37: 41. 1974; Napp-Zinn, Anat. Blat. 153, 160, 244, 283, 394, 434, 632, 658, 1079, 1092, & 1326. 1974; Gunn & Dennis, World Guide Trop. Drift Seeds 78, 79, 210, & 216, fig. 23. 1976; Moldenke, Phytologia 33: 238—270, 507, & 510. 1976; Norman, Fla. Scientist 39: 20 & 30. 1976; Raven, Evert, & Curtis, Biol. Pl., ed. 2, 427 & 670, fig. 210-12. 1976; E. H. Walker, Fl. Okin. & South. Ryuk. 895—896, pl. 18. 1976.

It should be noted here that knee-roots are reported for Avicennia (A. marina) in Tanzania by McCusker (1971), that the so-called "river mangrove" of Africa is Aegiceras corniculatum, and that Walker (1976) is now also among the long list of taxonomists to accept the Avicenniaceae as a valid family, giving "Hirugi-damashi zoku" as the vernacular name for the genus in Okinawa and the southern Ryukyu Islands.

AVICENNIA ALBA Blume

Additional & emended bibliography: Santapau, Bull. Bot. Surv. India 8: 37 & 291. 1966; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 1, 714. 1969; Corner & Watanabe, Illustr. Guide Trop. Pl. 750 & 751. 1969; Tan & Keng, Journ. Singapore Nat. Acad. Sci. 1: 8—29. 1969; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 2, 714. 1974; Moldenke, Phytologia 33: 239—241 & 260. 1976.

Conn & Katik describe this tree as to 20 m. tall, the bole 6

m. tall, the trunk diameter 45 cm. at breast height, the bark dark-brown, the sapwood cream, and the leaves dark-green above and pale-green beneath. They encountered it in coastal swamps, on "sandy grey-black soil due to accumulation of litter".

The corollas on Soepadmo & Mahmud KLU.9158 are said to have been "greenish-yellow" when fresh, and these collectors describe the plant as a tree, 15 m. tall, the trunk 20 cm. in diameter, and found it growing in a "disturbed" mangrove forest. The Kasim bin Rajab s.n. [12.10.1963] collection, cited below, consists only of very small seedlings.

The Khoo & Ming N/K.069, Mahmud s.n. [May 1970], Poore 123, Poore & Kassim 335, B. C. Stone 5931 & s.n. [Dec. 1967], and Stone & Halle 11032, distributed as typical A. alba, actually represent var. latifolia Moldenke.

Additional citations: MALAYA: Selangor: Kasim bin Rajab 102 (Kl—1102), s.n. [12.10.1963] (Kl—1792). Trengganu: Soepadmo & Mahmud KLU.9158 (Kl—12954). GREATER SUNDA ISLANDS: Sarawak: Carrick & Enoch JC.422 (Kl—3397). Sebatik: Tanglon A.1582 (Kl). NEW GUINEA: Papua: Conn & Katik LAE.66065 (Mu).

AVICENNIA ALBA var. LATIFOLIA Moldenke

Additional bibliography: Moldenke, Phytologia 32: 453. 1975.

Recent collectors describe this plant as a common small tree, 6—8 m. tall, with short stilt-roots [Khoo & Ming N/K.069] and erect pneumatophores, the trunk 10—15 cm. in diameter, the bark smooth, not fissured, and the leaves long and pointed, white beneath. The corollas are said to have been "greenish-yellow" on Soepadmo KLU.9162 and "orange" on Khoo & Ming N/K.069. It has been found growing in mangrove swamps from sealevel to 5 m. altitude, flowering in May, July, and August, in fruit in February, July, and September.

Material of this variety has been misidentified and distributed in some herbaria under the name, A. intermedia Griff.

Additional citations: MALAYA: Selangor: Khoo & Ming N/K.069 (Kl—8636); Mahmud s.n. [May 1970] (Kl—13368); Poore 123 (Kl—123); Poore & Kassim 335 (Kl—1335); B. C. Stone 5931 (Kl—5613), s.n. [Dec. 1967] (Kl—8561); Stone & Halle 11032 (Kl—17081). Trengganu: Soepadmo KLU.9162 (Kl—12958).

AVICENNIA ELLIPTICA Holm

Additional synonymy: Trepanocarpus inundatus Mart., in herb.

Additional bibliography: Moldenke, Phytologia 32: 438 & 454—455 (1975) and 33: 255, 256, 262, 268, & 269. 1976.

AVICENNIA EUCALYPTIFOLIA Zipp.

Additional & emended bibliography: Mukherjee & Chanda, Geophyt. 3: 86 & 88, text fig. 1 & pl. 1, fig. 2. 1973; Moldenke, Phytologia 33: 240—241. 1976.

Material of this species is sometimes misidentified and distrib-

uted in some herbaria under the designation, A. marina var. australasica (Walp.) Moldenke

Additional citations: GREAT BARRIER REEF: Bewick: Thom 4163 (N).

AVICENNIA GERMINANS (L.) L.

Additional synonymy: Avicennia tomentosa Weigelt ex Moldenke, Fifth Summ. 1: 394, in syn. 1971 [not A. tomentosa Blanco, 1845, nor Blume, 1918, nor R. Br., 1851, nor L., 1826, nor Roxb., 1835, nor Schau., 1940, nor "sensu Marc.", 1971, nor "sensu Mayc.", 1965, nor Sieber, 1944 (in part), nor Vahl, 1921, nor Wall., 1851].

Additional bibliography: Wangerin in Just, Bot. Jahresber. 50 (1): 44. 1929; G. W. Thomas, Tex. Pl. Ecolog. Summ. 77. 1969; R. W. Long, Fla. Sci. 37: 41. 1974; Gunn & Dennis, World Guide Trop. Drift Seeds 78, 79, 210, & 216, fig. 23. 1976; Moldenke, Phytologia 33: 238 & 241—270. 1976; Norman, Fla. Scientist 39: 20 & 30. 1976; Raven, Evert, & Curtis, Biol. Pl., ed. 2, 427 & 670, fig. 20-12. 1976.

Additional illustrations: Gunn & Dennis, World Guide Trop. Drift Seeds 79, fig. 23. 1976; Raven, Evert, & Curtis, Biol. Pl., ed. 2, 427, fig. 20-12. 1976.

The corollas are said to have been "white" on Breedlove & Thorne 20806, D. S. Correll 46449, and Plowman 3540. In addition to months previously reported in these notes, it has been found in anthesis in December.

Pételot (1953) gives a lengthy and detailed description of the medicinal uses of what purports to be this species (although he mis-applies it to A. officinalis L.) in Cuba, Mexico, Guadeloupe, and French Guiana. Especially interesting is his description of its use in the treatment of leprosy. "Les Docteurs Mathias Duque et Moreno, de Cuba, ont employé le médicament sous forme d'extrait fluide ou d'extrait mou. Prendre matin et soir une cuillerée à café d'extrait fluide en augmentant la dose jusqu'à ce qu'on arrive à huit, dix ou douze cuillerées à café par jour. Pour l'extrait mou, il est administré en pilules ou en solution concentrée, la dose maxima est de 6 à 8 grammes par jour. Ce traitement est généralement très bien toléré et donne rarement lieu à des nausées, des vomissements ou des douleurs intestinales.

"Localement, on applique sur les ulcères de la lèpre des compresses imbibées d'une solution aqueuse de 50 percent d'extrait fluide. Il est également utile de faire prendre au malade tous les soirs, avant le coucher, un bain de température de 39° à 49° et de 15 à 20 minutes de durée, que l'on additionne d'une décoction d'écorce de Palétuvier en quantité suffisante pour colorer en rouge l'eau du bain.

"Bocquillon préconise, une fois par jour, un verre à bordeux de vin de Palétuvier, fait avec du vin rouge dans la proportion du vin quinquina du Codex.

"Sous l'influence de ce traitement, l'amélioration apparaît en général au bout de 15 à 20 jours, l'appétit et le sommeil renais-

sent et les névralgies deviennent moins intenses.

"Le mois suivant, les taches violacées de la peau prennent une teinte rosée et pâlissent, notamment à la périphérie, et des espaces de peau saine reparaissent là où étaient des macules confluentes.

"En même temps, les ulcérations suppurent avec moins d'abondance et la cicatrisation est complète vers le huitième mois. La sensibilité commence à se rétablir au quatrième mois, lorsque toutefois la conservation du nerf en permet le retour.

"Ces résultats sont variables, naturellement selon la phase à laquelle est arrivé le mal au moment où le traitement a commencé. C'est ainsi que, dans tous les cas de lèpre à la période du début où les Docteurs Duque et Moreno ont eu recours au Palétuvier, la guérison a eu lieu dans l'espace de 8 à 10 mois. Parmi les malades ayant atteint la période d'état, mais avec envahissement nul ou à peine marqué des viscères, 60 percent auraient été guéris dans un espace de temps de 2 à 5 ans, et en moitié moins de temps on aurait obtenu la guérison sociale. Les stigmates de la lèpre n'étaient plus apparents et la malade n'offrait plus de danger de contagion pour l'entourage. Enfin, lorsque la lèpre est parvenue à la troisième période, le Palétuvier n'a plus d'action sur les névrites ni sur les troubles trophiques, mais il est susceptible d'amener une amélioration notable: disparition de la diarrhée et de la fièvre et augmentation du poids du corps.

"Des expériences de contrôle établies à la léproseries de la Havane ont confirmé la guérison dans quelques cas, l'amelioration se serait manifestée très souvent; toutefois, on ne saurait indiquer le Palétuvier comme un médicament spécifique absolu de la lèpre."

In Guiana, he says, "La lépre s'y étendait d'une façon fâcheuse et il était grand temps d'enrayer le fléau. Les résultats obtenus furent satisfaisants et nous ferons connaître plus tard les résultats obtenus d'une façon méthodique." He further remarks that the work of 146 pages by Mathias Duque, published in 1905, confuses Rhizophora mangle with Avicennia: "ce sont là des sujets très différents".

Gunn & Dennis (1976), in speaking of Avicennia germinans, assert that it is disseminated by the "Seedling, sprouted fruit, or rarely unsprouted fruit.....Seedling....up to 12 cm long with a conspicuous hairy root and 2 greenish cotyledons. Sprouted fruit.. up to 5 cm long, 2.5 cm wide, oblong to elliptical, compressed in cross section, dark brown, smooth (hairy when fresh), bearing a protruding hairy root. Unsprouted fruit....similar but lacking the protruding root." They say that the "Unfolded cotyledons are said to serve as miniature boats, but this does not explain how germinating and non-germinating fruits float. It would appear that buoyancy is due to buoyant seedling or fruit tissues." They further assert that buoyancy lasts about a year and that nearly 100 percent of the seedlings are viable.

These authors further comment that "Unlike most dissemimules, the black mangrove usually drifts as seedlings, not as seeds or

fruits. The fruit acts as a surrogate seed coat, because the seed coat is absent. The embryo germinates while the fruit is still attached to the parent tree. When the seedling drops, it may be self-planted in the mud below the parent tree, or be carried out into the ocean by the tide. Black mangroves are frequent to common members of the tidal swamps along the tropic and subtropic coasts of the New World and west Africa. Black mangrove was introduced into west Africa by man. While the red mangrove (Rhizophora mangle) and its relatives have rugged appearing drift seedlings, black mangrove seedlings appear to be so delicate that they would not be able to withstand the vicissitudes of drifting or being stranded. Black mangrove disseminules are amazingly hardy, as Guppy (1917) discovered when he dried some mature fruits for 25 days at room temperature. The fruits lost 50 percent of their weight during the drying process. Yet they germinated when placed in fresh water. In our buoyancy tests, the fruits and seedlings often become soft and rotted, indicating that not all of them are as seaworthy as disseminules protected by a bony fruit or seed wall. Other common names for the black mangrove include salt-bush, because salt crystals are often gathered from the leaves, and honey mangrove, because of the excellent honey made from the floral nectar."

It should be stated here that I have found absolutely no evidence thus far in literature or elsewhere to substantiate the above claim that Avicennia was introduced from America to west Africa by man. I regard the west African population as A. africana P. Beauv., related to but distinct from A. germinans (L.) L., most similar to forms of A. germinans var. guayaquilensis (H.B.K.) Moldenke and A. tonduzii Moldenke.

The D. H. Knight 1032 and J. A. Steyermark 62900, previously regarded by me as typical A. germinans, seem better placed as var. guayaquilensis (H.B.K.) Moldenke although strongly resembling the typical form.

Additional & emended citations: MEXICO: Chiapas: Breedlove & Thorne 20806 (N). CAMPECHE BANK: Alacran: F. R. Fosberg 41866 (N, W—24309910), 41904 (W—2430969). JAMAICA: "J. C." S.54 (Kl—7426). TURKS AND CAICOS ISLANDS: Providenciales: D. S. Correll 46449 (N). COLOMBIAN CARIBBEAN ISLANDS: San Andres: A. Gentry s.n. [August 4, 1967] (Ws). COLOMBIA: Atlántico: Plowman 3540 (N). Chocó: Duke 9703 (Oh). Guajira: Romero-Castañeda 4496 (Ac). Magdalena: Romero-Castañeda 7275 (Ac). VENEZUELA: Carabobo: Robertson & Austin 213 (Ld). Delta Amacuro: Budowski 98a-18 (Gz, N), 118-18 (Gz, Kh, N), 2032-19 (Kh, N). Zulia: Budowski 25 (Ac, Gz, N); H. M. Curran 250 (N), 252 (N), 252a (N), 254 (Ac, Gz, Kh, N). Baira Island: Budowski 96-28 (N). SURINAM: Hostman 1140 (Pd). ECUADOR: Esmeraldas: Harling 1696 (S); Sparre 18130 (S). GALAPAGOS ISLANDS: Indefatigable: L. A. Fournier 81 (Ac). Narborough: F. R. Fosberg 44703 (Ld).

AVICENNIA GERMINANS var. GUAYAQUILENSIS (H.B.K.) Moldenke

Additional bibliography: Moldenke, Phytologia 33: 249, 250, 255, 257, 259, 261, 262, & 267—270. 1976.

Steyermark encountered what appears to be this variety on sand dunes and flats of Sucre, Venezuela, although the leaves closely approximate those of typical A. germinans (L.) L.

Additional citations: VENEZUELA: Sucre: J. A. Steyermark 62900 (Mi, N). GALAPAGOS ISLANDS: Indefatigable: D. H. Knight 1032 (Ac, Ws).

AVICENNIA LANATA Ridl.

Additional synonymy: Avicennia officinalis δ spathulata Kuntze, Rev. Gen. Pl. 2: 502. 1891. Avicennia officinalis δ spathulata f. tomentosa Kuntze, Rev. Gen. Pl. 2: 502. 1891. Avicennia tomentosa Auct. ex Kuntze, Rev. Gen. Pl. 2: 502, in syn. 1891 [not A. tomentosa Blanco, 1845, nor Blume, 1918, nor R. Br., 1851, nor Jack, 1945, nor Jacq., 1760, nor L., 1826, nor L. & Jacq., 1783, nor G. F. W. Mey., 1818, nor Nutt., 1947, nor Nutt. & Br., 1832, nor Roxb., 1835, nor Schau., 1940, nor Sieber, 1844, nor Sw., 1864, nor Vahl, 1921, nor Wall., 1851, nor Weigelt, 1851, nor Willd., 1800, nor sensu Marc., 1965].

Additional bibliography: Ten & Keng, Journ. Singapore Nat. Acad. Sci. 1: 8—29. 1969; Moldenke, Phytologia 33: 270. 1976.

This species is based on Burkill & Watson 3793 & 3797 from Singapore and on Watson 2767 from Pahang. Burkill (1966) comments that this is the "largest of the Malayan species, attaining 100 feet in height, and commonly 70—80 feet. It grows gregariously on the east coast of the [Malay] Peninsula, and is found in Singapore, but not on the west coast."

It should be noted here that Burkill, in the work cited above, reduces to synonymy under A. lanata the A. marina var. rumphiana and A. officinalis, "of many authors". Whether he intends to include here the true A. marina var. rumphiana (H. Hallier) Bakh. or just that "of many authors", as he does the A. officinalis "of many authors, is not clear.

It should also be pointed out that the A. tomentosa of Blanco, referred to in the synonymy above, is a synonym of A. marina var. rumphiana (H. Hallier) Bakh., that of Blume is A. alba Blume, that of Brown and of Sieber (in part) is A. marina var. resinifera (Forst. f.) Bakh., that accredited to Jack, to Jacquin, to Linnaeus, to Linnaeus & Jacquin, to Meyer, to Nuttall, to Nuttall & Brown, to Sieber (in part), to Swartz, and to Weigelt is A. germinans (L.) L., that credited to Linnaeus, to Vahl, and to Wallich is A. marina (Forsk.) Vierh., that credited to Roxburgh and to Willdenow is A. officinalis L., and that credited to Schauer and to "sensu Marc." is A. schaueriana Stapf & Leechman.

Additional citations: MALAYA: Singapore: Gill 22 (Ft—9699).

AVICENNIA LANCEOLATA (Engelh.) Moldenke

Additional bibliography: Moldenke, Phytologia 14: 328. 1967; Moldenke, Fifth Summ. 1: 375 (1971) and 2: 531 & 839. 1971; Moldenke, Phytologia 32: 365. 1975.

AVICENNIA MARINA (Forsk.) Vierh.

Additional & emended synonymy: Racka torrida J. F. Gmel. in L., Syst. Nat. Veg. 2: 245. 1791. Avicennia officinalis γ ovatifolia Kuntze, Rev. Gen. Pl. 2: 502. 1891. Avicennia nitida Thunb. ex Alston in Trimen, Handb. Fl. Ceylon 6: Suppl. 233, in syn. 1931 [not A. nitida (Alter.) Sessé & Moç., 1956, nor Blanco, 1837, nor Jacq., 1760, nor L., 1960, nor L. & Jacq., 1783, nor Rodsch., 1844, nor Sessé & Moç., 1894]. Avicennia marina Vierh. apud Prain, Ind. Kew. Suppl. 4: 21. 1913. Avicennia mariana Vierh. ex Moldenke, Phytologia 7: 210, in syn. 1960. Avicennia racemosa Cornwell ex Moldenke, Phytologia 7: 210, in syn. 1960. Avicennia officinalis "sec. auct. afr." apud Dale & Greenway, Kenya Trees 581, in syn. 1961 [not A. officinalis Auct. ex Allen, 1961, nor Auct. ex Jafri, 1973, nor Blume, 1960, nor Kurz, 1885, nor L., 1753, nor (L.) Kurz, 1938, nor H. J. Lam, 1940, nor Millsp., 1930, nor Miq., 1918, nor Schau., 1856, nor Watt, 1958]. Avicennia maritima Maurois & Roux, Bull. Inst. Fond. Afr. Noire 27: 851, sphalm. 1965. Avicennia officinalis "L. sensu lat." apud Gaussen, Legris, & Viart, Ind. Counc. Agr. Res. Map Ser. 2: 16, in syn. 1965. Avicennia marina Forsk. ex Gaussen, Legris, & Viart, Ind. Counc. Agr. Res. Veg. Map Ser. 2: 16. 1965. Avicennia marina (Forst.) Vierh. apud J. M. Ward, Veget. Act. Geobot. 14: 247, sphalm. 1967. Avicennia marina (Forsk.) Vierk. apud Lewis & Naidoo, S. Afr. Journ. Sci. 66: 268, sphalm. 1970. Avicennia marina (G. Forst.) Vierh. apud Foreman, Div. Bot. Dept. For. N. Guin. Bot. Bull. 5: 63. 1972. Avicenna marina Cloudsley-Thomp., Terrestr. Environ. 36, sphalm. 1975. Avicennia marina L. ex Moldenke, Phytologia 28: 453, in syn. 1974.

Additional & emended bibliography: J. F. Gmel. in L., Syst. Nat., ed. 13, imp. 1, 2: 260. 1789; J. F. Gmel. in L., Syst. Nat. Veg. 2: 245. 1791; J. F. Gmel. in L., Syst. Nat., ed. 13, imp. 2, 2: 260. 1796; Wall., Numer. List 86. 1831; Decne., Nouv. Ann. Mus. Nat. Paris 3: 403. 1834; Harv., Gen. S. Afr. Pl., ed. 1, 271. 1838; Voigt, Hort. Suburb. Calc. 473. 1845; W. Griff., Notul. Pl. Asiat. 4: 188—189. 1854; Drury, Useful Pl. India 57. 1858; Amico, Erbar. Trop. Firens. Publ. 11: 18, 22, 31, & 33. 1868; Harv., Gen. S. Afr. Pl., ed. 2, 293. 1868; Balf. f., Bot. Socotra 237 & 414. 1888; H. N. Ridl., Journ. Straits Med. Assoc. 5: 136. 1897; Almagia in Pirotta, Fl. Col. Erit. [Ann. Inst. Bot. Roma 8:] 135. 1903; Dunn & Tutcher, Kew Bull. Misc. Inf. Addit. Ser. 10: 205. 1912; Chiov., Result. Scient. Miss. Stef. 1: 142—143 & 217. 1916; Wells, Philip. Journ. Sci. A.12: 111. 1917; H. Hallier, Meded. Rijks Herb. Leid. 37: 87—91. 1918; Paranjpye, Agric. Journ. India 15: 350. 1920; Wangerin in Just, Bot. Jahresber. 51 (1): 553. 1923; Sakag., Gen. Ind. Fl. Okin. 18. 1924; Heyne, Nutt. Pl. Ned. Ind. 1325.

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Recent collectors refer to this plant as a small and low or medium-sized tree or treelet, 1.3—23 m. tall, wide-spreading, and much-branched, or a shrub, 1.5—4 m. tall, dome-shaped, branching near the ground, growing singly or gregarious, sometimes growing beneath A. alba Blume or close to A. marina var. angustata Moldenke, often a crooked willow-like tree forming thickets, usually with very numerous, closely packed, slender, vertical, erect, root-processes ["rhizophores"] or pneumatophores, some as far as 6.5 m. from the trunk, or "stunted and without pneumatophores", rarely with prop-roots, the trunk to 14 cm. in diameter, with 5—36-inch girth, gray, the bole sometimes 2 feet in girth 10 feet above the ground, or shrubs with a 5-foot crown, the outer bark surface smooth and gray or reddish-brown to green, dark-green, yellowish-green, or light yellowish-green, sometimes grayish-green with thin pinkish-red papery flakes, the living bark green, the stems glaucous, the branches gray, with jointed leafless suckers, the sap colorless, the leaves light yellowish-green, acutely pointed, bicolored, paler or white beneath, the flower-buds green or greenish, the flowers aromatic and honey-scented with a slightly sourish-sweet odor, 4-merous, "rare" at the ends of the spreading lower branches, the calyx green, petals 4, stamens 4, alternating with the petals, exserted, the pistil yellow, and the fruit round [Maxwell 72-335], soft-tomentose, glaucous-green or dull-green, tinged yellowish or orange [Santos 5148] when ripe.

The corollas are said to have been "yellow" on Amaratunga 1830, Bernardi 11814, Cooray 69073011R, Fosberg 52048, Geesink & Santisuk 5230, Read 2172, Stoddart 1515, Tanner 2464, and Tirvengadum & Waas 465, "bright-yellow" on Fosberg 51242, "deep-yellow" according to Beard (1970), "yellow-orange" on Chai S.26762 & S. 26765, "orange-yellowish" on Chai S.27541, "orange-yellow" on Chai PC.2, S.22950, & S.29948, Fosberg 48675, Meijer 752, and Meijer & Balakrishnan 131, "orange" on Cooray 6909280R & 69100505R, Fosberg 37425, Gillis 8388, Maxwell 71-349, and Santos 4748, "dull-orange" on Amaratunga 110 and Simpson 9850, "yellow to orange" on Van der Kevie 2, and "bluish" on Pancho 2085.

Cooray, on the labels on one of his collections, states "tree 3 cm tall", but obviously this is a stenographic error for "3 m." since his specimens is not a seedling. Wood samples accompany Chai 8.29950 in some herbaria. The tree represented by Winter

7713 is said to have been photographed by the collector.

Pollen of A. marina was studied by Mukherbee & Chanda (1973) on the basis of Bakhuizen 449 from Java in the Utrecht herbarium and has been described as "tricolporate; colpi ca. 25 mu x 5 mu (range 22—35 mu x 4—5.5 mu), with thin margin; ora lelongate, confined within the limits of the colpi, ca. 9 x 5 mu (range 5—12 mu x 3—6 mu); mean intercolporal distance 13 mu; amb convex; sexinal part of exine projected outward and devoid of any ornamentation; mean apocolpium diameter 11 mu; prolate-spheroidal to spheroidal, P/E ca. 32 x 31 mu (range 27.5—36 mu x 26.5—36 mu); exine 3.5 mu thick; sexine 2.5 mu thick, reticulate, intectate, muri simplibaculate, rarely duplibaculate, heterobrochate, lumina polygonal, dimensions gradually becoming smaller toward the aperture; bacula provided with distinct globular knob-like head; nexine 1 mu thick, tenuinexinous; NPC classification 345.

Fig. 1. Avicennia marina showing numerous air-roots on under side of leaning trunk. Rejang Mangrove Forest Reserve, Sarawak. Photograph courtesy of Paul Chai, Forest Botanist, Sarawak, 1975.

Huang (1972) describes the pollen as "Grains 3-colporate; subprolate to spheroidal; 28—37 x 24—30 mu; amb circular-lobate; aperture common type, ora transversally parallel; exine 2 mu thick; tectum with verrucate processes; sexine reticulate, with OL-pattern; nexine thinner than sexine" [on the basis of Chang 2229].

Recent collectors have encountered A. marina on sandy shores in and above the tidal level, in mixed mangrove forests, along riversides, on sand bars, rocky seashores, moist lagoon bunds, open beaches, saline flats alongside of brackish pools, in coppices, in disturbed former mangrove areas, on "firm sandy flats with very little mud at river-mouths", "on consolidated sandy mus", in "flat soft silty mud near banks in mangrove forests", in "brackish water at highwater line", or "in sand inundated at high tide on sand flats back of beach-rock exposures", at altitudes of sealevel to 15 meters, flowering from January to July, September, and October, and in fruit in January, March to July, and September. Wirter reports it "forming most of the central area of swamps"; Cooray found it "common" in Sri Lanka; Perdue & Kibuwa refer to it as "locally dominant with Rhizophora, Ceriops, and Bruguiera. In New Caledonia MacDaniels reports it "occasional on dry hillsides, alt. 15 m." — a remarkable find. In Sri Lanka, according to Grupe, it is "commonly scattered on dry sandy flats or locally abundant in moist shallow depressions just back of sandy beaches", while Fosberg and his associates report it occasional there "near shrub-belt well back from beach on sand flats". Chai reports it "common on open inundated beaches" in Selangor.

Shantz refers to A. marina as the "chief tree of semi-tidal flats". Williams found it in "less inundated sites" in Zanzibar. Van der Kevie found it to be "very common on moderately firm soils" in Thailand. Pancho refers to it as "a littoral species throughout the Philippines". Fosberg describes it as "common especially in periphery of wooded area in mangrove scrub forest" on Aldabra island, "flooded by spring tides", "infrequent on lagoon shore in mangrove swamp on sandy bottom" on Euphrates island, and "common generally especially on lagoon beach ridges in mosaic of halophytic vegetation on low sand islands" on Manauli island.

Amico & Bavazzano (1968) report the species from Zambezia, Mozambique. Worrell & Sourry (1967) assert that in Australia the pneumatophores it produces are called "cobblers' pegs" and that "Up-river [it is] often associated with the bushy 'river mangrove' (Aegiceras corniculatum). The roots on the seedling develop very rapidly to catch up with and maintain the upper growth" and, further, that it is "found along the whole of the Australian coast extending to the cool climates of southern Victoria" [actually these statements apply in major part to var. resinifera (Forst. f.) Bakh. rather than to true A. marina]. Rao & Mukherjee (1967) refer to A. marina as the "chief mangrove in [the] belt fringing low muddy shores" in Saurashtra, India.

McCusker (1971) reports the presence of knee-roots on A. marina in Tansania and specimens in various stages of development

are described and illustrated: "They arise from horizontal roots in a manner similar to pneumatophores but anatomically they resemble horizontal roots. After re-entering the soil the knee-root reverts to a horizontal position and gives rise to further pneumatophores and anchoring roots. When seen above the soil they appear superficially similar to the knee- or elbow-shaped roots produced by Bruguiera and Ceriops. They emerge to a height of 6—8 cm. above the soil or approximately half the height of the surrounding pneumatophores."

It should be noted here that Bakhuizen (1921) recorded the presence of air-roots on Avicennia marina, saying: "As a curiosity let us further remark that there are sometimes to be found air-roots on Avicennia trunks (I saw this with the variety intermedia but possibly the same occurs with other species or varieties). These air-roots are very similar to the breathing-roots, except that their direction is not negative-geotropic, but on the

Fig. 2. Avicennia marina showing prop-roots and pneumatophores. Rejang Mangrove Forest Reserve, Sarawak. Photograph courtesy of Paul Chai, Forest Botanist, Sarawak. 1975

contrary they grow downwards. They occur along the stems up to a height of two meters, and if the trees are standing in a oblique position, one finds these roots on the lower side in a row close to each other. These air-roots remain short and thus do not reach the ground, but branch off. Within they are not spongy and fibrous like the breathing-roots, but ligneous. I mention this case for trees which stand on places where the marshes were filled up with sand, while the breathing-roots were more or less buried under the

ground. Probably this abnormal formation of air-roots was due to the breathing, which was prevented by the sand filling in the marsh."

Prop-roots were found by Chai on A. marina in Sarawak, as well as on A. alba Blume and on A. officinalis L., and air-roots on A. marina (see Fig. 1), but here occurring in areas where the pneumatophores were not sand-covered, as can easily be seen in the photographs (Fig. 1 & 2) very kindly sent to me by Paul Chai, Forest Botanist of Sarawak. He asserts that he has found trees with such prop-roots "to be confined to soft muddy soils".

Bakhuizen (1921) regards only the populations in East Africa and Arabia as representing the true A. marina (Forsk.) Vierh. He regards those to the east [tropical Asia, Indonesia, and Melanesia] as var. intermedia (W. Griff.) Bakh. This may prove to be a desirable segregation, but at present I see no good way of distinguishing these presumed taxa morphologically. Some very small roundish-leaved specimens from the Malayan area certainly seem fairly distinct, but may actually represent A. sphaerocarpa Stapf. They hardly fit into Bakhuizen's characterization of var. intermedia although they have been so regarded by some workers.

Backer & Bakhuizen (1961) use the name, A. marina var. intermedia, for A. marina as it occurs in Java, describing it as having "Flowers in 2—12-flowered heads; lowermost flower-pair sometimes distant from the other ones, but nevertheless the inflorescence not spiciform; adult heads 1/2 — 1 1/5 cm long; style robust, c. 1 1/2 mm long; stigmas recurved. Leaves elliptic-oblong or oblong-obovate, from an acute base, with an obtuse or rounded top, greenish white beneath, 3—9 cm by 1 1/4 — 4 1/2 cm..... mangrove (also in the more saline parts), banks of tidal streams".

Griffith (1846) has stated that his A. intermedia — the basis for Bakhuizen's A. marina var. intermedia — is "altogether intermediate between what appears to be A. tomentosa and A. resinifera". To exactly which "A. tomentosa" he is here referring is not clear. The A. tomentosa of Blanco is now known as A. marina var. rumphiana (H. Hallier) Bakh., that of Blume is A. alba Blume, that of Robert Brown and of Sieber (in part) as A. marina var. resinifera (Forst. f.) Bakh., that of Jack, Jacquin, Linnaeus & Jacquin, G. F. W. Meyer, Nuttall, Nuttall & Brown, Sieber (in part), Swartz, and Weigelt is A. germinans (L.) L., that credited to Linnaeus, to Vahl, and to Wallich is true A. marina, and that of Roxburgh and of Willdenow is A. officinalis L., while that accredited to Schauer, to "sensu Marc.", and to "sensu Mayc." is A. schaueriana Stapf & Leechman. I assume that Griffith is referring to the A. tomentosa of Roxburgh and therefore to A. officinalis L. It is true that typical A. marina does appear more or less intermediate between A. officinalis and A. marina var. resinifera, but this does not indicate or even imply that it is a hybrid between them.

Greenway (1973) asserts that A. marina is the "common dominant on the landward sides of the [saline water] swamp forest" in East

Africa. Alston (1931) distinguishes the two Sri Lankan species as follows:

1. Leaves obtuse, obovate; anthers exserted; style elongate, villous; corolla over 1/4 inch across; capsules 1—1 1/2 inches across; ovary hairy [throughout].....A. officinalis.

1a. Leaves acute, elliptic; anthers included; style very short, glabrous; corolla under 1/4 inch across; capsule 1/4 — 1 inch across; ovary hairy at apex only.....A. marina.

He assert that A. marina is "common on the seacoasts of Ceylon, also on all tropical Asian shores".

It should be noted here that the A. officinalis Auct. ex Jafri, referred to in the synonymy on page 76, is a synonym of A. marina var. acutissima Stapf & Moldenke, while the homonym referred to as A. officinalis Auct. ex Allan is A. marina var. resinifera (Forst. f.) Bakh., that credited to Blume is the true and valid A. officinalis L., that credited to Kurz, to H. J. Lam, to "(L.) Kurz", and to Watt is A. alba Blume, that accredited to Millspaugh is A. germinans (L.) L., that credited to Schauer is A. marina var. rumphiana (H. Hallier) Bakh., and that of Miquel is A. eucalyptifolia Zipp. The A. nitida Blanco, referred to on the same page, belongs in the synonymy of A. marina var. rumphiana, while the homonym credited to "(Alter.) Sessé & Moç", to Jacquin, to Linnaeus, to Linnaeus & Jacquin, to Rodschuh, and to Sessé & Moçino are A. germinans (L.) L.

Altman & Dittmer (1966) refer to A. marina as the "black mangrove", but they, as well as Biebl (1964), erroneously list A. nitida Jacq. as a synonym — Jacquin's binomial is a synonym of A. germinans. The "A. marina" of Jafri (1973) is plainly var. acutissima Stapf & Moldenke. Uphof (1968) reduces A. alba Blume to the synonymy of A. marina, but this disposition is entirely untenable to me because A. alba has plainly spicate inflorescences and very much differently shaped leaves and fruits. The "A. tomentosa L." of Wallich (1831), of Decaisne (1834), of Harvey (1838), and of Drury (1858) actually is A. marina. Harvey (1838) asserts that "It is found pretty generally through the tropics, and in countries bordering on them, in similar situations" — a statement which is far too broad, applicable, really, only to the genus as a whole, rather than to any one species like this one. No form of A. marina occurs in the New World.

The "A. officinalis L." of Harvey (1868), of Matsumura (1899), of Baker (1900), of Almagia (1903), of Dunn & Tutcher (1912), of Sakaguchi (1924), of Parthasarathy (1927), of Sasaki (1928), of Makino & Nemoto (1931), of Nemoto (1936), of Sonohara, Tawada, & Amano (1952), of Naito (1953), of Montasir & Hassib (1956), of Verguin (1956), of Khattab & El-Hadidi (1971), and of Weiss (1972) is actually A. marina.

Melchior (1964), DeWit (1967), and Amico & Bavazzano (1968)

list "A. officinalis L." as a synonym of A. marina, while Corner & Watanabe (1969) reduce A. marina to the synonymy of A. officinalis, but these are absolutely untenable dispositions — the A. officinalis of Linnaeus is a separate, very distinct, and valid species [see Alston's distinguishing characters as quoted on page 85].

Masamune (1955), misidentified as A. officinalis, records A. marina from Fukien, Taiwan, Iriomoto, Ishigaki, Komi, Miyako, and Obama. Ragam (1957), also misidentifying the plant as A. officinalis, quotes Verguin (1956) to the effect that "à Madagascar, l'infusion de feuilles est préconisées contre la fièvre jaune". As yet I have been unable to check the illustrations of "A. officinalis said to be in Annal. Mus. Colon. Marseille, ser. 4, 4: 2, pl. 64 (1926) and in Mém. Acad. Malgache 5: pl. 20, fig. 56 (1927), but if these apply to Madagascar plants too, then probably they also depict A. marina rather than the true A. officinalis.

Kohlmeter (1971) reports a fungus on what he identifies as "A. germinans" from South Africa, but the only species of Avicennia in South Africa is A. marina. Steinke (1972) found the species more widely distributed in Cape Province [Cape of Good Hope] than Bruguiera gymnorrhiza. Bavazzano (1972) reports it from Afars & Issis Territory. Täckholm (1956) tells us that A. marina is found on the Red Sea coasts and on adjacent islands of Egypt, where it is known locally as "shoara". Montasir & Hassib (1956) also assert that it is frequent along the Red Sea coasts. Foreman (1972) records it from Bougainville island and Williams (1949) from Pemba and Zanzibar, where, he says, it is usually found "at higher levels in [the] mangrove association". Gaussen and his associates describe it as "serving as colonizer on mangrove deltas" and of "intertidal zones and estuaries".

Speck (1968) states that A. marina grows with Rhizophora stylosa, Aegiceras corniculatum, and Osbornia octodonta, forming a dense single-layered forest 20—40 feet tall, access to which is difficult because of the density of the forest and the deep tidal mud in which it grows. Beard (1967) report that "A colony of Avicennia marina was found along a salt creek [in Western Australia] leading from an inland source through a series of small salt lakes and salt flats to an estuary-like area along the '80-mile Beach'". This, he says, "gives us an example of an inland locality for this species." He discusses habitat factors and the accompanying vegetation, emphasizing the factors which could have led to such an establishment of an inland mangrove colony. The species is also known to me from several inland salt lakes in northeastern Africa.

Chapman (1970) proposes the ecologic associations, Avicennietum marinae and Avicennieto albae-A. marinae.

The Gillis 8388 collection, cited below, cultivated in Florida, was grown there from seeds gathered on Formosa and planted at the edge of a tidal swamp in marl. Kassas, Mobarak, & Omar 636 and

Täckholm, Kassas, Faway, Shalaby, Samy, & Zahran 1150 consist of seedling specimens.

Additional vernacular names to those previously reported by me for this species are "black mangrove", "grey mangrove", "hái-ka-tang", "hái-ka-tîn", "hirugidamasi", "hirugi-damashi" [=hirugi, mangrove, damashi, to be deceived, implying that one is deceived into thinking that this is the true mangrove plant, the true mangrove being Rhizophora], "hirugi-damasi", "hirugi-modoki", "isi kungathi", "isí-kungati", "kanamaram", "kanna", "mcandalla", "mchuu wood", "mtswi", "mtu", "mutu", "salgheiro", "shoara", "shora", "takhai", "takhaye", "takhei", "tobase", "tokhai", and "venkandan".

Arulchelvam (1968) describes A. marina as it grows in Sri Lanka: "A bush or small tree, much branched, white bark; young twigs quadrangular. Leaves 2 to 3 inches long and 1 to 1 1/2 inches broad, 6 to 8 opposite veins, Petioles 1/4 to 1/2 inch. Dark green above and silvery white below with densefine pubescence. Oblanceolate, acute at base. Flowers. — In terminal or axillary panicles, yellow, corolla 1/2 inch diameter. Fruit. — Capsule about 1 inch, obliquely ovoid, compressed, glabrous, pale greenish yellow. Wood. — Has included phloem does not burn well.... Distributed in all the mangrove swamps in Ceylon. Produces a large number of pneumatophores of 6 to 18 inches height and 1/4 to 1/2 inch thick." As usual, this is a hodgepodge of A. marina and A. officinalis characters!

Palmer & Pitman (1972) refer to A. marina as "the southernmost mangrove in Africa". They assert that from the Kabonqaba River in Cape Province "it extends northwards along the coasts of Natal, Zululand, and Portuguese East Africa to tropical Africa and the Red Sea, and eastwards to the tropical shores of both hemispheres [actually, it does not occur naturally in the Western Hemisphere at all!].....This is the boldest of the mangroves, the pioneer and first coloniser, starting life on the fringes of the lagoon and inlet shores, sending up from its wide-spreading horizontal roots its numerous pencil-like 'breathing-roots' which father silt, in time making around them a muddy and waterlogged world in which other mangrove species of the genera Rhizophora and Bruguiera take over. Unlike the trees of these species, it is a sun-lover, tending to disappear at length under the new conditions it creates. In a mangrove swamp it usually constitutes the outer fringe. Its roots are often covered at high tide and it can stand a considerable degree of salinity.

"It is a shrub or small, slender, willow-like tree up to about 6 m high — its height, it is suggested, depending largely on the type of soil, for it flourishes best where drainage is good. Unlike the other mangroves, the foliage appears light and airy, the leaves often growing upwards. The trunk, which usually grows at an angle, is most often slender and light-coloured, covered with small raised dots and occasionally flaking to show green below."

They describe the "thousands" of pneumatophores as 15—38 cm. long and state that "among them scuttle hundreds of tiny dark

crabs feeding on the fallen fruit.....They [the trees] bloom from August to October.....The seedlings.....are not long and cigar-shaped as in Bruguiera and Rhizophora, but small -- about 2.5 cm. long -- cone-shaped, well-formed for mobility, and easily borne and scattered by the tidal waters. After they have fallen the cotyledons unfold and develop. Birds of various species nest in the tree", including cattle egret, little egret, gray heron, black-headed herons, and golden weavers; "Bronze Mannikins roost in it. The Wattle-eyed Flycatcher is sometimes to be seen feeding in avicennia groves, flitting about and catching insects with a loud snap of its bill. The Mangrove Kingfisher is associated with it as far south as the last dense avicennia grove on the Kobonqaba River.

"Sim called this the least useful and most persistent of the three hardy mangroves [in South Africa]. He described the wood as grey or yellowish, prettily dotted and fairly dense and even, the older timber with a darker centre and often damaged. It is said to be durable and is used for poles, and in parts of Africa in ship-building -- the ribs of dhows are sometimes fashioned from it. In Tongaland the framework of the local fish traps, which are large and conical, is made from it. The bark and roots contain tannin and a brown dye is obtained from the bark."

Chai (1972) describes A. marina in Sarawak as a "Shrublet (2 ft. tall) to medium-sized tree -- 60 ft. tall. No buttresses but slender, soft stilt roots may develop. Bark reddish-brown, flaking off in irregular, thin papery flakes revealing green new bark surface.....A pioneer species on new mud with a high proportion of sand but does not seem to colonise pure mud. At the mouth of the Bako river, it is slowly been replaced by A. alba. Found also along sandy shores where it is seen to be in poor form and never gregarious. Absent inland."

Dale & Greenway (1961) assert that in Kenya A. marina "is a first coloniser of poor swamp land. Once established mud usually accumulates amongst its pneumatophores producing conditions favourable for Ceriops and occasionally Rhizophora. In established swamps the tree occupies the zone on the landward side."

Amico & Bavazzano (1968) say of its uses: "Radici: afrodisiaco. Frutto: il frutto immaturo è usato per curare piaghe e lesioni cutanee da vaiolo. Semi: cotti in acqua sono adoperati coma cicatrizzanti di ferite. Pianta intera: contiennne tannino."

Burkill (1966) says: "A tree usually not more than 40 feet high, though sometimes up to 70 feet, found gregariously on the sea-face of the mangrove belt....It is a very valuable tree from the point of view of anchoring mud, and after a time it gives place to the more valuable Bruguiera caryophylloides.....as this happens, it becomes a scant value."

Moll and his associates (1972) note that the mangrove association in South Africa is "important for the conservation of the estuaries which are needed during the life cycles of many marine organisms" and "in some areas around the larger cities it has been almost completely destroyed".

Uphof (1968) asserts that the hard wood is used to make pillars of houses and also as fuel, the aromatic bitter juice is used as an abortive, and the bark is employed in tanning. Williams (1949), on the other hand, says that in Pemba and Zanzibar it is "useless for tanning". Yet Dale & Greenway (1961) report that in Kenya "A brown dye is obtained from the bark. The bark and leaves have up to 6 per cent tannin. The timber is used for dhow ribs and is liked as fuel for lime burning." Harvey (1838) asserts that in South Africa the bark is used for tanning. Williams (1949) claims that in Zanzibar the trunks are used to make canoes, in cart building, as fittings for dhows, as masts, bedstools, drums, chairs, and handles, and "Used as fuel in lime burning". Tanner avers that in Tanzania the leaves are boiled and the resulting liquid is then drunk in treating fevers.

Parsa (1947) states that small relict communities of this plant (which he misidentifies as A. officinalis) are found on tidal estuaries at intervals along the Gulf of Aden coast from beyond Jibuti to Karin and probably to Cape Gardafui. Chiovenda reports them from along the eastern Somali coast. Parsa avers that it does not seem able to adapt itself there to deeper water and so grows nearer to the edges, sometimes even on "dry" ground where it can attain a height of 20 feet. It supplies building timber for gurghis, the bark is "rich in tannin", and it provides good stock feed especially for camels and because of this it is being depleted very rapidly.

Watt & Breyer-Brandwijk (1962), erroneously identifying the plant as A. officinalis, list its uses in southern and eastern Africa as follows: the bark and roots are used for tanning "and the wood has been explored as a possible source of paper pulp. The root has been used as an aphrodisiac and a cataplasm of the unripe fruit for sores and for healing the skin lesions of smallpox."

Burkill (1966) informs us that "About the Red Sea and the Persian Gulf, where fodder is a thing of much value, the leaves of A. marina are eaten by camels.....Cattle eat the leaves of the Australian Avicennia, or Grey Mangrove, with great relish. A green, bitter and somewhat aromatic resin oozes from the bark. This resin is medicinal round about the Indian Ocean. An Arab writer calls it an aphrodisiac, and adds that it may also be applied for toothache. In western Java it is considered a contraceptive, and is taken over indefinitely long periods....This use is given, also, by Ridley as known among the Malays....but in his prescription the abortient juice of a young pine-apple is associated. Watt.....says that the roots possess aphrodisiac properties. He says that unripe seeds are used as a poultice to hasten boils and abscesses to maturity. The ash, after burning the wood, is used as soap in India.....and Baker tells us that early settlers used it similarly in Australia. There is a large amount of alkali in it.....Wood-tar was made from it experimentally by Wells."

Leshem & Levison (1972) report that A. marina "manifests several regulation mechanisms enabling survival in extreme saline

and anaerobic conditions. Anatomical adaptations include vertically growing aerial roots — pneumatophores, extending above sea level at high tide and which are equipped with aerenchyma and profuse lenticels thus enabling 'tidal breathing'. Physiological adaptations include high osmotic potentials — 69 atmospheres — as measured by Vapour Pressure Equilibrium method, and active ion excretion from lower epidermis of foliage. Ultra-filtration seems the case only for the CO_3^{--}, SO_4^{--} and Mg^{++} ions. The transpirational system apparently is affected by salt encrustations on the leaves only to a minor degree."

Shimony, Fahn, & Reinhold (1973) have found the salt glands of A. marina to consist of "2—4 collecting cells, 1 stalk cell and usually 8 secretory cells. The side wall of the stalk cell is completely impregnated with electron-dense material. An amorphous substance appears between the upper walls of the secretory cells and the cuticle above them. The latter possesses many narrow channels. The ultrastructure of the secretory cells was studied under various conditions. The protoplast is usually dense and poorly vacuolated. The nucleus is relatively large and the cytoplasm rich in organelles, especially endoplasmic reticulum (E.R.) elements, Golgi bodies and mitochondria. There are many vesicles which appear to be derived from the Golgi bodies and from E.R. cisterns. Elongated vacuole-like structures, apparently derived from Golgi cisterns, and membranous bands were also observed: it is suggested that both represent different stages of the same structure. In many glands the protoplast appeared to be contracted in one of the secretory cells and the space between it and the cell wall was filled with an amorphous electron-dense substance. Antimonate precipitation and electron probe analysis were employed to locate ions in the tissues. Both techniques indicated that the salt content of the gland cells was lower than that of the mesophyll. A downhill gradient appeared to exist from cells near the xylem, through the mesophyll to the gland, and was continued through the gland itself." Rains & Epstein (1967) have investigated the preferential absorption of potassium by the leaf-tissue in the presence of high concentrations of sodium chloride.

Connor (1969) reports that when A. marina was grown in nutrient cultures to which a range of concentrations of NaCl, KCl, and CaCl were added, all levels of KCl and CaCl suppressed growth, but there was a positive growth response to NaCl, the optimum level being about 1.5 percent, which is half the concentration of sea water.

Puri (1960) reports an osmotic pressure of 48.5 atmospheres in A. marina, as compared to 38.6—41.29 in A. alba and 41.93 in A. officinalis. Other mangroves had the following pressures: 31.45 in Sonneratia alba, 14.99—45.46 in S. apetala, 31.6—33.7 in Rhizophora mucronata, 26.65—32.45 in Ceriops candolleana, 24.92—33.25 in Acanthus ilicifolius, and 27.9—32.23 in Bruguiera gymnorrhiza.

Lewis & Naidoo (1970) have investigated the effect of tidal inundation on the apparent transpirational rhythm of A. marina by use of a Ganong potometer. "The apparent transpiration rate of this plant rises in the morning with increasing light intensity and decreasing relative humidity until a mid-morning maximum is attained. Thereafter a progressive decrease in rate takes place during the rest of the day, regardless of atmospheric conditions. Tidal inundation of the swamp after the mid-morning maximum results in an increase in apparent transpirational rate and the attainment of a 2nd maximum, indicating that the initial decrease in rate was probably caused by incipient wilting following excessive transpiration and consequent increased soil water tension."

Bell & Duewell (1961) have isolated betulic acid, taraxerol, taraxerone, and traces of a hydrocarbon (probably triacontane) from the bark.

It is perhaps also worth noting here that the Blume (1826) reference in the bibliography of A. marina is often cited as "1825". Burkill cites the Baker (1915) reference as "1916". The Foreman (1972) work is sometimes cited as "1971", the title-page date. Similarly, the Täckholm & Boulos (1974) work is cited as "1972", the title-page date, but the work was not actually published until November 20, 1974. The Griffith (1846) reference is sometimes given as "1851" and the Chapman (1960) work as "1954".

Dale & Greenway (1961) cite Graham 231, Greenway 8933, Jeffery 125, Swynnerton 196, and Webber 617 from Kenya. Amico & Bavazzano (1968) cite their no. 448 from "Inhassunge: lungo le sponde del fiume Bons Sinais e suoi affluenti nella mangrovia". Iyengar (1927) lists an "A. officinalis", which is probably A. marina, from Krusada in the South Indian Sand Cays, where Stoddart & Fosberg (1972) cite Stoddart 1515 from West Cay, Stoddart 1614 from New Cay, and Fosberg 51242 from Manauli Cay. Khattab & El-Hadidi (1971) cite their no. 210 from Hejaz. Fosberg & Renvoize (1970) cite Fosberg & Grubb 49825 and Fryer 22 from Wizard Island and Gwynne & Wood 1260 and Stoddart & Poore 1225 & 1259 from Menai Island.

Fosberg (1970) cites Fosberg & Frazier 49758, Hemsley s.n., Ridgeway 67, Veevers-Carter 67, and Vesey-Fitzgerald 5960 from Astove Island. Bayne and his associates (1970) record the species from Cosmoledo Atoll, Menai Island. Täckholm (1969) cites Kaiser 79, 909, 948, 980, and a photograph. Voigt (1845) records it as cultivated in the Calcutta suburbs in India. Huang (1972) cites Chang 2229 from Formosa (Taiwan).

The R. M. King 5588 & 5601 and Orolfo 690, distributed as A. marina, are actually A. alba Blume, while Havel NGF.17393 and Soepadmo KLU.9162 are A. alba var. latifolia Moldenke, Latz 3391 [Herb. North. Terr. 36913] and Neth. Ind. For. Serv. bb.24334 are A. eucalyptifolia Zipp., Budowski 96-288 & 118-18 are A. germinans (L.) L., Lohen 14879, Medway s.n., and Turnau 745 are A. marina var. rumphiana (H. Hallier) Bakh., Sterimann & Lelean

NGF.18468 is A. officinalis L., and Schlieben 11753 is not avicenniaceous. Gardner s.n. [Thwaites C.P.1961] is a mixture of A. marina and A. officinalis.

Additional citations: EGYPT: Boulos 445 (Gz); Collector undetermined s.n. (Gz 4 sheets); Hassib s.n. [Jan. 18—25, 1930] (Gz 3 sheets), s.n. [30/1/1930] (Gz 5 sheets); Hassib & Fahmy s.n. [11/1/33] (Gz 7 sheets); Nayal s.n. [23/1/1929] (Gz 4 sheets); Osborn & Helmy s.n. [9/3/1967] (Gz); Sabat & Nayal s.n. [Ghargada, July 1933] (Gz 5 sheets); G. Schweinfurth 966 (W—2497120); G. Täckholm s.n. [21/1/1929] (Gz 34 sheets); Täckholm, Kassas, Fawzy, Shalaby, Samy, & Zahran 1150 (Gz 10 sheets), 1151 (Gz 7 sheets), 1428 (Gz, Gz), 1593 (Gz 3 sheets); Täckholm, Kassas, Samy, Girgis, & Zahran 7 (Gz, Gz), 24 (Gz 3 sheets), 450 (Gz, Gz); Zahran & Girgis 43 (Gz 3 sheets), 71 (Gz 3 sheets), 86 (Gz). SUDAN: Red Sea: Kassas 829 (Gz), 865 (Gz 6 sheets), s.n. [5.1.1956] (Gz 4 sheets); Kassas, Mobarak, & Omar 636 (Gz, Gz), 931 (Gz), 1170 (Gz 3 sheets). BAKIYAI ISLANDS: Aqiq: Kassas, Mobarak, & Omar 920 (Gz 3 sheets). ERITREA: Pappi 3168 (W—1969130). ABU MENQAR ISLAND: Sabat & Nayal s.n. [6 July 1933] (Gz 5 sheets); Täckholm, Kassas, Samy, Girgis, & Zahran 47 (Gz 3 sheets). REPUBLIC OF SOMALI: Renner s.n. [Oktober 1930] (Mu). TANZANIA: Tanganyika: Perdue & Kibuwa 8475 (Mu); Schlieben 5787 (Mu); Tanner 2464 (Ba, N), 3414 (Ba, N); Verdoorst 132 (Mu). KENYA: Greenway 8933 (N), 8935 (N); Greenway & Rawlins 8875 (N). MOZAMBIQUE: Manica e Sofala: Shantz 365 (W—1657224). SOUTH AFRICA: Natal: Strey 6727 (Mu); Wirter 7713 (Mu). COMORO ISLANDS: Aldabra: F. R. Fosberg 48674 (N), 48675 (N). Euphrates: F. R. Fosberg 48779 (N). SEYCHELLES ISLANDS: Cousin: F. R. Fosberg 52048 (W—2680166). Mahé: Jeffrey & Zelia 494 (N). NOSY-BÉ: L. Bernardi 11814 (W—2749344). ARABIA: Hedjaz: Khattab 210 (Gz); Migahid 14 (Gz), 515 (Gz); Schimper 736 (Mu). Yemen: Ibrahim K.2328 (Gz). Province undetermined: Schimper s.n. [Ad mare rubrum] (Mu). PERSIAN GULF ISLANDS: Tarut: Khodair 36 (Gz); Migahid & Hammouda 104 (Gz). INDIA: Gujarat: Jain s.n. [Bhaunagar, Gogha, 13.5.1957] (Gz). Karnataka: Thanikaimoni s.n. [Karwar, 6.4.75] (Ld). Kerala: Manilal 10 (Ac). Tamil Nadu: Thanikaimoni s.n. [Pichavaram, 17.7.1973] (Ld). SOUTH INDIAN SAND CAYS: Manauli: F. R. Fosberg 51242 (W—2669635). New: Stoddart 1614 (W—2625112, W—2625113). West: Stoddart 15151 (W-2625018). SRI LANKA: Amaratunga 110 (Pd), 1830 (Pd), 2073 (Pd); Balakrishnan NBK.362 (Pd, W—2720383); Collector undetermined s.n. [Jaffna, Feb. 1870] (Pd), s.n. [Panadura] (Pd), s.n. [Puttalam lagoon] (Pd, Pd); Cooray 69073011R (N, W—2657004), 69092801R (W—2657006), 69100505R (W—2657005); Fosberg, Mueller-Dombois, Wirawan, Cooray, & Balakrishnan 50914 (Ld); G. Gardner s.n. [Thwaites C.P.1961, in part] (Pd); Gould & Cooray 13670 (Pd, W—

2574884a); Grupe 106 (Pd, W—2611411), 110 (Pd, W—2611412); Macrae s.n. [Kalpitiya, Oct. 21, 1968] (N, W—2680246), s.n. [November 10, 1968] (W—2679407, W—2680249); Meijer 752 (Pd, W—2760727); Meijer & Balakrishnan 131 (Pd, W—2716022); Moldenke, Moldenke, & Jayasuriya 28246 (Ac, E, Gz, Kh, Ld, Pd, Tu, W—2765420); R. W. Read 2172 (W—2691085); J. M. de Silva s.n. [Puttalam] (Pd); Y. W. de Silva s.n. [Negombo] (Pd); N. D. Simpson 9856 (Pd); Thwaites C.P.1961, in part (Pd); Tirvengadum, Cramer, & Balasubramium 244 (W—2764110); Tirvengadum & Waas 465 (N); Worthington 478 (Pd), 4386 (Pd), 4891 (Pd). SRILANKAN ISLANDS: Erumativu: Macrae s.n. [October 22, 1968] (W—2679408). THAILAND: Geesink & Santisuk 5240 (Ac); Larsen & Larsen 33784 (Ac); J. F. Maxwell 71-349 (Ac), 72-335 (Ac); Surapat 358 (W—2450897); Van der Kevie 2 (N). MALAYA: Singapore: Chai PC.2 (Kl—14975); Gill 24 (Ba, Ft—9689, Ld); Mahmud s.n. [May 1970] (Kl—13370). RYUKYU ISLANDS ARCHIPELAGO: Ishigaki: F. R. Fosberg 37425 (Ld, W—2628908). PHILIPPINE ISLANDS: Bosan: J. V. Santos 4748 (W—2246293). Luzon: Gill 1 (Ac, Ft—9730, Ld), 2 (Ft—9731); Mabanag s.n. [Philip. Nat. Herb. 9599] (W—2125857, W—2376130, W—2376131); Pancho 2085 (Ba). Mindanao: H. H. Bartlett 13706 (Mi). Mindoro: Conklin s.n. [Philip. Nat. Herb. 18725] (W—2214844); J. V. Santos 5148 (W—2246563). GREATER SUNDA ISLANDS: Java: Backer 15324 (Mu, Mu), s.n. [Batavia] (Mu, Mu); Renner s.n. [26. 11.1930] (Mu). Sarawak: Carrick & Enoch JC.265 (Kl—3250); Chai S.26762 (Ac, Ft, Ld), S.26763 (Ld), S.26765 (Ac), S.27541 (Ld), S.29948 (Ld), S.29950 (Ac), S.30627 (Ac), S.30660 (Ld). LESSER SUNDA ISLANDS: Wetar: Neth. Ind. For. Serv. bb.27297 (N). NEW CALEDONIAN ISLANDS: New Caledonia: L. H. MacDaniels 2010 (Ft—3852). CULTIVATED: Florida: Gillis 8388 (Ac, Ft—4717). LOCALITY OF COLLECTION UNDETERMINED: Collector undetermined 59 (Pd).

AVICENNIA MARINA var. ACUTISSIMA Stapf & Moldenke

Additional synonymy: Avicennia marina var. acutissima Stapf & Moq. ex Rao, Aggarwal, & Mukherjee, Bull. Bot. Surv. India 8: 65, sphalm. 1966. Avicennia alba Auct. ex Raizada, Indian Forester 92: 306, in syn. 1966 [not A. alba Blume, 1826, nor Karst., 1907, nor Miq., 1891, nor Wight, 1921]. Avicennia officinalis Auct. ex Jafri in Nasir & Ali, Fl. West Pakist. 49: 2, in syn. 1973 [not A. officinalis Auct. ex Allan, 1961, nor Auct. ex Cuf., 1962, nor Blume, 1960, nor Kurz, 1885, nor L., 1753, nor "L. sens. lat.", 1965, nor (L.) Kurz, 1938, nor H. J. Lam, 1940, nor Maxim., 1932, nor Millsp., 1930, nor Miq., 1918, nor Schau., 1856, nor "sec. auct. afr.", 1961].

Additional bibliography: C. B. Clarke in Hook. f., Fl. Brit. Ind. 4: 604. 1885; T. Cooke, Fl. Bomb. Presid. 2: 436. 1906; Parsa, Fl. Iran 4 (1): 536—537. 1949; Raizada, Indian Forester 92: 302. 1960; S. A. Khan, Pakist. Journ. Forest. 11: 43—45.

1961; Jafri, Fl. Karachi 290, 339, & 351, fig. 285. 1966; Raizada, Indian Forester 92: 306. 1966; Rao, Aggarwal, & Mukherjee, Bull. Bot. Surv. India 8: 65. 1966; Santapau, Bull. Bot. Surv. India 8: 37, 40, & 291. 1966; Esfandiari, Prem. Liste Fl. Herb. Minist. Agr. Iran 252. 1967; Rao & Mukherjee, Bull. Bot. Surv. India 9: 81, 83, 84, & 86, fig. 1. 1967; Rao & Shanware, Bull. Bot. Surv. India 9: 244 & 247. 1967; Santapau, Bull. Bot. Surv. India 8, Suppl. 1: [Fl. Saurashtra] 38. 1967; Moldenke, Phytologia 15: 476. 1968; Moldenke, Résumé Suppl. 16: 9. 1968; Shah & Patel, Bull. Bot. Surv. India 12: 20 & 25. 1970; Moldenke, Fifth Summ. 1: 267, 271, 279, & 392 (1971) and 2: 839. 1971; Patel, Forest Fl. Gujarat 35 & 227. 1971; Moldenke, Phytologia 23: 422. 1972; R. R. Stewart, Annot. Cat. in Nasir & Ali, Fl. West Pakist. 605. 1972; Jafri in Nasir & Ali, Fl. West Pakist. 49: 2—4, fig. 1. 1973; Simon, Dorner, & Hartshorn in Lowson, Textb. Bot., ed. 15, [64], pl. 3. 1973; Moldenke, Phytologia 28: 453 (1974), 29: 173 (1974), 31: 389 (1975), and 32: 442, 443, & 452. 1975.

Illustrations: S. A. Khan, Pakist. Journ. Forest. 11: 45 (in color) [as "A. officinalis"]. 1961; Jafri, Fl. Karschi fig. 285 [as "A. alba"]. 1966; Jafri in Nasir & Ali, Fl. West Pakist. 49: 3, fig. 1 [as "A. marina"]. 1973; Simon, Dorner, & Hartshorn in Lowson, Textb. Bot., ed. 15, pl. 3. 1973.

This taxon has been confused widely with A. alba Blume by practically all authors up to 1938 and even since then by Jafri (1966) and by Stewart (1972), as A. officinalis L. by Khan (1961), and as typical A. marina (Forsk.) Vierh. by Jafri (1973). Raizada (1966) comments that "Apparently two different plants, one from the east coast and one from the west coast of India have been going under the name A. alba Bl. The east coast specimens [the true A. alba] are trees with lax inflorescence and cylindrical fruits. The west coast specimens are shrubs with compact inflorescence and laterally compressed fruits. From Blume's description it is difficult to determine as to which of these two is the real A. alba Blume. I have followed Moldenke here who identifies the west coast specimens as A. marina var. acutissima Stapf & Moldenke."

It should also be pointed out here, for the record, that the A. alba of Miquel, referred to in the synonymy above, is a synonym of A. alba Blume, while the homonym credited to Karsten is really A. eucalyptifolia Zipp. and that credited to Wight is the typical A. marina (Forsk.) Vierh. The A. officinalis credited to Kurz, to H. J. Lam, and to "(L.) Kurz" is a synonym of A. alba Blume, while that credited to Miquel is A. eucalyptifolia Zipp., that credited to "Auct. ex Cuf.", to "L. sens. lat.", to Maximowicz, and to "sec. auct. afr." is typical A. marina (Forsk.) Vierh., and that credited to Millspaugh is A. germinans (L.) L. The so-called A. officinalis Auct. ex Allan is really A. marina var. resinifera (Forst. f.) Bakh., A. officinalis Schau. is A. marina var. rumphiana (H. Hallier) Bakh., while that credited to Blume is the true A. officinalis L. [to be continued]